INTERNET AND INTRANET CONNECTIVITY THROUGH WIRELESS LOCAL AREA NETWORK (WLAN)

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Abstract: *There is an increasing demand for newer Wireless Local Area Network (WLAN) systems to meet the emerging data communication challenges with respect to reliability, performance and cost. The wired networks have some problems which cannot be overcome; these can be achieved by using WLAN. This paper presents the site survey, link budget and device installation procedure for establishing a WLAN connection at some remote place including some theoretical and practical ideas about the radio frequency properties, modulation techniques, antennas and WLAN.*

Keywords: *WLAN,*

1. Introduction:

Wireless Local Area Network (WLAN) is a kind of local area network which established using a wireless link between the service providers and the clients using some wireless equipment [1].

The key features of WLAN are

- Linking of two or more computers without using wires.
- Utilizes spread-spectrum or OFDM (IEEE 802.11a) modulation technology based on radio waves to enable communication between devices in a limited area, also known as the basic service set.
- Provides mobility to the users.

At present many people and companies or organizations in our country want internet and intranet connectivity to meet the benefit of the modern communication systems. WLAN system supports both the internet and intranet connectivity. There are many ISP (Internet Service Provider) companies those who give WLAN facilities to those peoples. These companies use wireless network systems to serve them. There are many reasons of using the wireless network in place of wired network. There are many problems of wired network like cost, security, difficulty in installation and maintenance, etc. Also the present situation of our overall environment is not suitable for the wired network. A wireless network also has some problems. But it is smaller than it's benefits.

2. RF Properties and Modulation Techniques:

The WLAN systems use microwave radio frequencies (RF) to establish the connections. So, to establish a wireless network one must have to have the knowledge of different RF properties. Radio frequencies are high frequency alternating current (AC) signals that are passed along a copper conductor and then radiated into the air via an antenna. The microwave radio frequency range is 1 GHz to 300 GHz.

The RF properties include gain, loss, reflection, refraction, diffraction, scattering, voltage standing wave ratio (VSWR) etc [2].

- **Gain:** Gain is usually an active process; meaning that an external power source, such as an RF amplifier, is used to amplify the signal or a high-gain antenna is used to focus the beam width of a signal to increase its signal amplitude.
- **Loss:** Loss describes a decrease in signal strength. It may occur for various reasons which will describe on the upcoming sections.
- **Reflection:** Reflection occurs when a propagating electromagnetic wave impinges upon an object that has very large dimensions when compared to the wavelength of the propagating wave. Sometime it causes gain of the signal to the receiving antenna, sometime it causes loss.
- **Refraction:** Refraction describes the bending of a radio wave as it passes through a medium of different density. As an RF wave passes into a denser medium the wave will be bent such that its direction changes.

Refraction can become a problem for long distance RF links. As atmospheric conditions change, the RF waves may change direction, diverting the signal away from the intended direction.

- **Diffraction:** Diffraction occurs when the radio path between the transmitter and receiver is obstructed by a surface that has sharp irregularities or an otherwise rough surface. It changes the direction of the radio wave.
- **Scattering:** Scattering occurs when the medium through which the wave travels consists of objects with dimensions that are small compared to the wavelength of the signal, and the number of obstacles per unit volume is large. Scattering can occur when a wave strikes an uneven surface and is reflected in many directions simultaneously which will cause loss of signal.
- **Voltage Standing Wave Ratio (VSWR):** VSWR occurs when there is mismatched impedance (resistance to current flow, measured in Ohms) between devices in an RF system. VSWR is caused by an RF signal reflected at a point of impedance mismatch in the signal path. VSWR causes return loss which is defined as the loss of forward energy through a system due to some of the power being reflected back towards the transmitter. If the impedances of the ends of a connection do not match, then the maximum amount of the transmitted power will not be received at the antenna. When part of the RF signal is reflected back toward the transmitter, the signal level on the line varies instead of being steady.

The communication system using the microwave radio signal can be disturbed by many means [3]. Those are

- **Line of site clearance:** To establish a microwave link the first thing is to find a line of sight path between the transmitter and the receiver. If it cannot get then the link setup will not possible.
- **Rain Attenuation:** Raindrop absorption or scattering of the microwave signal can cause signal loss in transmissions.
- **Screening:** if there are hindrances between transmitter and receiver, the signals will weaken. A connection can thus become problematic and impossible.
- **Multi-path fading**: Multi-path fading occurs from multi-path propagation of the radio waves through reflection, refraction and diffraction. It leads to phase shifted reception of signals of different paths. The interference can distort, amplify or erase the signal.
- **Fresnel Zone Clearance:** Fresnel Zone Clearance is the minimum clearance over obstacles that the signal needs to be sent over. Reflection or path bending will occur if the clearance is not sufficient.
- **Interference & Noise:** There are many types of interference occurs in microwave communication. Those are co-channel interference, adjacent channel interference. Noises also hamper the link. Noise can be created from the microwave ovens, high voltage equipments, etc.

Digital modulation techniques like BPSK, QPSK, QAM or OFDM are used in WLAN's microwave link. For shorter distance QAM will give a high data rate without any problem. But for longer distance BPSK is better. OFDM is the most preferred one from all aspects.

Spread spectrum technology allows taking the same amount of information than previously using a narrow band carrier signal and spreading it out over a much larger frequency range [4]. Thus spread spectrum technique is used in this communication. There are two types of spread spectrum – Frequency Hopping Spread Spectrum, Direct Sequence Spread Spectrum.

- **Frequency Hopping Spread Spectrum (FHSS):** Frequency hopping means to change the frequency used for transmission is consequently changed for every TDMA frame following a certain frequency hopping algorithm. Both the transmitter and the receiver know the algorithm. Spread spectrum using this technique is called the FHSS.
- **Direct Sequence Spread Spectrum:** Direct sequence spread spectrum is very widely known and the most used of the spread spectrum types, owing most of its popularity to its ease of implementation and high data rates. The majority of wireless LAN equipment on the market today uses DSSS technology. DSSS is a method of sending data in which the transmitting and receiving systems are both on a 22 MHz-wide set of frequencies. The wide channel enables devices to transmit more information at a higher data rate than current FHSS systems. The process of direct sequence

begins with a carrier being modulated with a code sequence. The number of chips in the code will determine how much spreading occurs, and the number of chips per bit and the speed of the code (in chips per second) will determine the data rate.

3. RF Antenna and Accessories:

An RF antenna is a device used to convert high frequency (RF) signals on a transmission line (a cable or waveguide) into propagated waves in the air. Antennas are most often used to increase the range of wireless LAN systems, but proper antenna selection can also enhance the security of wireless LAN.

There are three generic categories of RF antennas [5]:

1. Omni-directional
2. Semi-directional
3. Highly-directional

When wireless LAN devices connect together, the appropriate cables and accessories need to purchase that will maximize throughput, minimize signal loss, and, most importantly, allow making connections correctly.

Different types of accessories are needed in a wireless LAN design [5].

1. RF Amplifiers
2. RF Attenuators
3. Lightning Arrestors
4. RF Connectors
5. RF Cables

4. Wireless LAN - Architecture:

Stations

All components that can connect into a wireless medium in a network are referred to as stations [1]. All stations are equipped with wireless network interface cards (WNICs). Wireless stations fall into one of two categories: access points and clients.

- **Access points:** Access points (APs) are base stations for the wireless network. They transmit and receive radio frequencies for wireless enabled devices to communicate with.
- **Clients:** Wireless clients can be mobile devices such as laptops, personal digital assistants, IP phones, or fixed devices such as desktops and workstations that are equipped with a wireless network interface.

Service Set

A service set is a term used to describe the basic components of a fully operational wireless LAN [1]. In other words, there are three ways to configure a wireless LAN, and each way requires a different set of hardware. The three ways to configure a wireless LAN are:

1. Basic service set
2. Extended service set
3. Independent basic service set

- **Basic service set**: When one access point is connected to a wired network and a set of wireless stations, the network configuration is referred to as a basic service set (BSS). A basic service set consists of only one access point and one or more wireless clients.
- **Extended service set:** An extended service set is defined as two or more basic service sets connected by a common distribution system.
- **Independent basic service set:** An independent basic service set is also known as an ad hoc network. An IBSS has no access point or any other access to a distribution system, but covers one single cell and has one SSID. The clients in an IBSS alternate the responsibility of sending beacons since there is no access point to perform this task.
- **Infrastructure basic service set:** An infrastructure BSS can communicate with other stations not in the same basic service set by communicating through access points.

Applications of WLAN

WLAN can be used in the following works.

1. Network Extension
2. Building-to-building Connectivity
3. Last Mile Data Delivery
4. Mobile access
5. Small Office-Home Office
6. Mobile Offices

5. Site Survey and Link Budget

RF site survey and link budget are a map to successfully implementing a wireless network. There is no hard and fast technical definition of a site survey. The site survey and link budget cannot be taken lightly, and can take days or even weeks, depending on the site being surveyed. The resulting information of a quality site survey and link budget can be significantly helpful for a long time to come.

- **Site Survey:** A site survey is a task-by-task process by which the surveyor discovers

the RF behavior, coverage, distance, interference, power supply condition and determines proper hardware placement in a facility [6, 7]. Site surveying involves analyzing a site from an RF perspective and discovering what kind of RF coverage a site needs in order to meet the business goals of the customer. During the site survey process, the surveyor will ask many questions about a variety of topics; these questions allow the surveyor to gather as much information as possible to make an informed recommendation about what the best options are for hardware, installation, and configuration of a wireless LAN.

A surveyor should find the following things at the site during the site survey

1. Location (latitude, longitude, elevation)
2. Power Condition
3. Building height
4. Existing tower height (if any)
5. Line of sight clearance
6. Bearings
7. Required equipments and accessories
8. Existing networks
9. Area usage and towers
10. Purpose and business requirements
11. Bandwidth and roaming requirements
12. Available other resources

▪ **Site Survey Equipment:** In the most basic cases a variety of antennas, antenna cables and connectors, a laptop computer (or PDA) with essential PC cards, some site survey utility software, GPS receiver, Spectrum Analyzer, wire stripers and power cables, multi-meter, and lots of paper. There are some minor things that can be added to mobile toolkit such as double-sided tape (for temporarily mounting antennas to the wall), a DC-to-AC converter and batteries (for powering the access point where there's no source of AC power), a digital camera for taking pictures of particular locations within a facility, a set of two-way radios if working in teams, and a secure case for the gear.

▪ **Link Budget:** A link budget is the accounting of all of the gains and losses from the transmitter, through the medium (free space, cable, waveguide, fiber, etc.) to the receiver in a telecommunication system [6, 7].

A simple link budget equation looks like below:

Received Power (dB) = Transmitted Power (dBm) + Gains (dB) - Losses (dB) (1)

For a line of sight radio system, a link budget equation might look like below:

RxP = TxP + TxG - TxL - FSL - ML + RxG - RxL (2)

Where,
RxP = received power (dBm)
TxP = transmitter output power (dBm)
TxG = transmitter antenna gain (dBi)
TxL = transmitter losses (coax, connectors) (dB)
FSL = free space loss or path loss (dB)
ML= miscellaneous losses (fading, body loss, polarization mismatch, other losses) (dB)
RxG = receiver antenna gain (dBi)
RxL = receiver losses (coax, connectors) (dB)

The whole microwave link design procedure can be illustrated as below

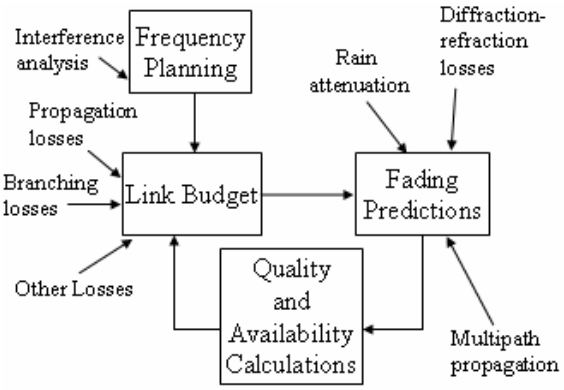

Fig. 1: Block Diagram of Link Design Process

After taking all sorts of data and calculation the microwave link for the WLAN can be installed.

6. Device Installation Process:

It is very important to have proper installation of the antennas in a wireless LAN. Improper installation can lead to damage or destruction of equipment and can lead to personal injury.

For the proper installation of the antennas in wireless LAN system following Parameter should maintain [8]

1. Placement
2. Mounting
3. Appropriate Use
4. Orientation
5. Alignment
6. Safety
7. Maintenance

Device installation procedure is almost same for all devices in software level. All the devices uses a in build software to install and configure it.

After finishing the hardware level installation it needs a PC (Laptop) to configure it. The configuration procedure can be as follows [9, 10]:

- First the device needs to connect with the PC using necessary connectors and cable. The PC must have the software needed for the device.
- Giving power on the device one can then access the device using the PC and software.
- It may take a password to access the device. Giving the password one can access the setup wizard of the device.
- There it will need the MAC address, frequency band, carrier frequency, BSS ID, BSU ID, different IP information, polarization, channel width, color code, hopping frequencies (if want to use hopping), duplex method, etc.
- After giving all above information properly the device will then start configuring itself and at last it will give the current link status. It includes the local and remote signal strength, SNR, jitter, throughput information, etc.
- Then the device will ask for finishing the installation. If the results are satisfactory then it can finish. But if it is not then the whole procedure can be redone changing the hardware settings.

7. Conclusion:

In our country the WLAN technology comes with a great opportunity for the corporate and home or small users. It gives us reliable and hassle free internet and intranet connection. Now we do not need to go to BTTB for a leased line to make a connection between two branch offices of a company. It also gives us secured data transmission facility. But still there are many problems with the connection of a WLAN; it does not support mobility in our country. And also the connection charge is not in reach of general people. If BTRC take necessary steps then it will be a helpful one and the people of our country will get internet and data connectivity all over the country.

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